1394-based Digital Camera Specification

Version 1.20

July 23, 1998

Sponsored by:
Camera Working Group of the 1394 Trade Association

Approved for Release by:
1394 Trade Association Board of Directors

Abstract: The purpose of this document is to act as a design guide for digital camera makers that wish to use IEEE 1394 as the camera-to-PC interconnect. Adherence to the design specifications contained herein do not guarantee, but will promote interoperability for this class of device. The camera registers, fields within those registers, video formats, modes of operation, and controls for each are specified. Area has been left for growth. To make application for additional specification, contact the 1394 Trade Association Camera Working Group.

Keywords: Camera, 1394, Digital Video

Table of contents

This page intentionally left almost blank.

1. Digital camera control command register

Base address for all digital camera command registers is:

Bus_ID, Node_ID , FFFF Fxxx xxxx (initial units space)

This address is contained in the configuration ROM in the camera unit directory.
The following sections define all the camera CSR registers. The offset field in each of the tables is the byte offset from the above base address.

1.1 Camera initialize register

Offset	Name	Field	Bit	Description
000h	INITIALIZE	Initialize	[0]	If assert this bit, Camera will re-set to initial (factory setting value) state.
		-	[1..31]	Reserved (All zero)

0-7	8-15	16-23	24-31
i	reserved (all 0)		

Initial values	Zeros
Read values	Zeros
Write effect	if '0' no effect, if '1' set initial state(Factory setting)

1.2 Inquiry register for video format/mode/frame rate

Each bit in the inquiry fields specify the availability of a given feature. A value of 1 indicates that the corresponding feature is implemented, a value of 0 indicates that the corresponding feature is not implemented.
The following sections define the inquiry registers.

1.2.1 Inquiry register for video format

Offset	Name	Field	Bit	Description
100h	V_FORMAT_INQ	Format_0	[0]	VGA non-compressed format. (Maximum 640x480)
		Format_1	[1]	Super VGA non-compressed format (1)
		Format_2	[2]	Super VGA non-compressed format (2)
		Format_x	[3..5]	Reserved for other format.
		Format_6	[6]	Still Image Format
		Format_7	[7]	Scalable Image Size Format
		-	[8..31]	Reserved. (All zero)

0-7	8-15	16-23	24-31
format	reserved (all 0)		

Initial values	System dependent.
Read values	System dependent. Same value to Initial value.
Write effect	Ignored.

1.2.2 Inquiry register for video mode

Offset	Name	Field	Bit	Description
180h	V_MODE_INQ_0 (Format_0)	Mode_0	[0]	160 X 120 YUV(4:4:4) Mode (24bit/pixel)
		Mode_1	[1]	320 X 240 YUV(4:2:2) Mode (16bit/pixel)
		Mode_2	[2]	640 X 480 YUV(4:1:1) Mode (12bit/pixel)
		Mode_3	[3]	640 X 480 YUV(4:2:2) Mode (16bit/pixel)
		Mode_4	[4]	640 X 480 RGB Mode (24bit/pixel)
		Mode_5	[5]	640 X 480 Y (Mono) Mode (8bit/pixel)
		Mode_x	[6..7]	Reserved for another Mode
		-	[8..31]	Reserved. (All zero)
184h	V_MODE_INQ_1 (Format_1)	Mode_0	[0]	800 X 600 YUV(4:2:2) Mode (16bit/pixel)
		Mode_1	[1]	800 X 600 RGB Mode (24bit/pixel)
		Mode_2	[2]	800 X 600 Y (Mono) Mode (8bit/pixel)
		Mode_3	[3]	1024 X 768 YUV(4:2:2) Mode (16bit/pixel)
		Mode_4	[4]	1024 X 768 RGB Mode (24bit/pixel)
		Mode_5	[5]	1024 X 768 Y (Mono) Mode (8bit/pixel)
		Mode_x	[6..7]	Reserved for another Mode
		-	[8..31]	Reserved. (All zero)
188h	V_MODE_INQ_2 (Format_2)	Mode_0	[0]	1280 X 960 YUV(4:2:2) Mode (16bit/pixel)
		Mode_1	[1]	1280 X 960 RGB Mode (24bit/pixel)
		Mode_2	[2]	1280 X 960 Y (Mono) Mode (8bit/pixel)
		Mode_3	[3]	1600 X 1200 YUV(4:2:2) Mode (16bit/pixel)
		Mode_4	[4]	1600 X 1200 RGB Mode (24bit/pixel)
		Mode_5	[5]	1600 X 1200 Y (Mono) Mode (8bit/pixel)
		Mode_x	[6..7]	Reserved for another Mode
		-	[8..31]	Reserved. (All zero)
18Ch: 197h	Reserved for other V_MODE_INQ_x for Format_x.			
198h	V_MODE_INQ_6 (Format_6)	Mode_0	[0]	Exif format
		Mode_x	[1..7]	Reserved for another Mode
		-	[8..31]	Reserved. (All zero)
19Ch	V_MODE_INQ_7 (Format_7)	Mode_0	[0]	Format_7 Mode_0
		Mode_1	[1]	Format_7 Mode_1
		Mode_2	[2]	Format_7 Mode_2
		Mode_3	[3]	Format_7 Mode_3
		Mode_4	[4]	Format_7 Mode_4
		Mode_5	[5]	Format_7 Mode_5
		Mode_6	[6]	Format_7 Mode_6
		Mode_7	[7]	Format_7 Mode_7
		-	[8..31]	Reserved. (All zero)

0-7	8-15	16-23	24-31
v_mode_inq	Reserved (all 0)		

Initial values	System dependent
Read values	System dependent. Same value to Initial value
Write effect	Ignored

1.2.3 Inquiry register for video frame rate and base address of the Video Mode CSR for the Scalable Image Size Format

Offset	Name	Field	Bit	Description
200h	V_RATE_INQ_0_0 (Format_0,Mode_0)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	Reserved
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_4	[4]	30fps
		FrameRate_x	[5..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
204h	V_RATE_INQ_0_1 (Format_0,Mode_1)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_4	[4]	30fps
		FrameRate_x	[5..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
208h	V_RATE_INQ_0_2 (Format_0,Mode_2)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_4	[4]	30fps
		FrameRate_x	[5..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
20Ch	V_RATE_INQ_0_3 (Format_0,Mode_3)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_4	[4]	30fps
		FrameRate_x	[5..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
210h	V_RATE_INQ_0_4 (Format_0,Mode_4)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_4	[4]	30fps
		FrameRate_x	[5..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
214h	V_RATE_INQ_0_5 (Format_0,Mode_5)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_4	[4]	30fps
		FrameRate_5	[5]	60fps
		FrameRate_x	[6..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
218h : 21Fh	reserved V_RATE_INQ_0_x (for other Mode_x of Format_0)			
220h	V_RATE_INQ_1_0 (Format_1,Mode_0)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_4	[4]	30fps
		FrameRate_x	[5..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
224h	V_RATE_INQ_1_1 (Format_1,Mode_1)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	Reserved
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps

		FrameRate_x	[4..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
228h	V_RATE_INQ_1_2 (Format_1,Mode_2)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	Reserved
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_4	[4]	30fps
		FrameRate_5	[5]	60fps
		FrameRate_x	[6..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
22Ch	V_RATE_INQ_1_3 (Format_1,Mode_3)	FrameRate_0	[0]	1.875fps
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_x	[4..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
230h	V_RATE_INQ_1_4 (Format_1,Mode_4)	FrameRate_0	[0]	1.875fps
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_x	[3..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
234h	V_RATE_INQ_1_5 (Format_1,Mode_5)	FrameRate_0	[0]	1.875fps
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_4	[4]	30fps
		FrameRate_x	[5..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
238h : 23Fh	reserved V_RATE_INQ_1_x (for other Mode_x of Format_1)			
240h	V_RATE_INQ_2_0 (Format_2,Mode_0)	FrameRate_0	[0]	1.875fps
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_x	[3..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
244h	V_RATE_INQ_2_1 (Format_2,Mode_1)	FrameRate_0	[0]	1.875fps
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_x	[3..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
248h	V_RATE_INQ_2_2 (Format_2,Mode_2)	FrameRate_0	[0]	1.875fps
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_x	[4..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
24Ch	V_RATE_INQ_2_3 (Format_2,Mode_3)	FrameRate_0	[0]	1.875fps
		FrameRate_1	[1]	3.75fps
		FrameRate_2	[2]	7.5fps
		FrameRate_x	[3..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
250h	V_RATE_INQ_2_4 (Format_2,Mode_4)	FrameRate_0	[0]	1.875fps
		FrameRate_1	[1]	3.75fps
		FrameRate_x	[2..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
254h	V_RATE_INQ_2_5 (Format_2,Mode_5)	FrameRate_0	[0]	1.875fps
		FrameRate_1	[1]	3.75fps

		FrameRate_2	[2]	7.5fps
		FrameRate_3	[3]	15fps
		FrameRate_x	[4..7]	Reserved for another FrameRate
		-	[8..31]	Reserved (All zero)
258h : 25Fh	reserved V_RATE_INQ_2_x (for other Mode_x of Format_2)			
260h : 2BFh	Reserved V_RATE_INQ_y_x (for other Format_y,Mode_x)			
2C0h	V_REV_INQ_6_0 (Format_6,Mode_0)	revision_0	[0]	Exif format revision 2.0
		revision_x	[1..7]	Reserved for other revision
		-	[8..31]	Reserved (All zero)
2C4h... 2DFh	reserved V_REV_INQ_6_x (for other Mode_x of Format_6)			
2E0h	V_CSR_INQ_7_0	Mode_0	[0..31]	CSR quadlet offset for Format_7 Mode_0
2E4h	V_CSR_INQ_7_1	Mode_1	[0..31]	CSR quadlet offset for Format_7 Mode_1
2E8h	V_CSR_INQ_7_2	Mode_2	[0..31]	CSR quadlet offset for Format_7 Mode_2
2ECh	V_CSR_INQ_7_3	Mode_3	[0..31]	CSR quadlet offset for Format_7 Mode_3
2F0h	V_CSR_INQ_7_4	Mode_4	[0..31]	CSR quadlet offset for Format_7 Mode_4
2F4h	V_CSR_INQ_7_5	Mode_5	[0..31]	CSR quadlet offset for Format_7 Mode_5
2F8h	V_CSR_INQ_7_6	Mode_6	[0..31]	CSR quadlet offset for Format_7 Mode_6
2FCh	V_CSR_INQ_7_7	Mode_7	[0..31]	CSR quadlet offset for Format_7 Mode_7

for Format_0, Format_1, Format_2:

0-7	8-15	16-23	24-31
frame_rate	reserved (all 0)		

for Format_6:

0-7	8-15	16-23	24-31
revision	reserved (all 0)		

for Format_7 (Scalable Image Size Format):

0-7	8-15	16-23	24-31
Base address of the Video Mode CSR (quadlet offset)			

"Base address of the Video Mode CSR" is the quadlet offset from the base address of initial register space.

Initial values	System dependent
Read values	System dependent (Same as initial value)
Write effect	Ignored

1.3 Inquiry register for basic function

All the field except "Memory_Channel" is bit assignment for inquiry.

(0:Not available 1:Available)

Offset	Name	Field	Bit	Description
400h	BASIC_FUNC_INQ	Advanced_Feature_ Inq	[0]	Inquiry for advanced feature. (Vendor Unique)
			[1..15]	Reserved
		Cam_Power_Cntl	[16]	Camera process power ON/OFF capability
			[17..18]	Reserved
		One_Shot_Inq	[19]	One shot transmission capability
		Multi_Shot_Inq	[20]	Multi shot transmission capability
			[21..27]	Reserved
		Memory_Channel	[28..31]	Maximum memory channel number (N) Memory channel no 0 = Factory setting memory 1 = Memory Ch 1 2 = Memory Ch 2 : N= Memory Ch N If 0000, user memory is not available.

0-7	8-15	16-23				24-31	
a	res	c	res	o	m	res	mem

“Advanced Feature” is vendor unique features. Vendor shall prepare CSR’s for these additional features and write base address of these CSR’s at 480h as a quadlet offset value from the base address of initial register space.

Initial values	System dependent
Read values	System dependent (Same as initial value)
Write effect	Ignored

1.4 Inquiry register for feature presence

All the field is bit assignment for inquiry. (0:Not available 1:Available)

Offset	Name	Field	Bit	Description
404h	Feature_Hi_Inq	Brightness	[0]	Brightness Control
		Auto Exposure	[1]	Auto Exposure Control
		Sharpness	[2]	Sharpness Control
		White_Balance	[3]	White Balance Control
		Hue	[4]	Hue Control
		Saturation	[5]	Saturation Control
		Gamma	[6]	Gamma Control Or ON/OFF
		Shutter	[7]	Shutter Speed Control
		Gain	[8]	Gain Control
		Iris	[9]	IRIS Control
		Focus	[10]	Focus Control
		Temperature	[11]	Temperature Control
		Trigger	[12]	Trigger Control
			[13..31]	Reserved
408h	Feature_Lo_Inq	Zoom	[0]	Zoom Control
		Pan	[1]	PAN Control
		Tilt	[2]	TILT Control
		Optical Filter	[3]	Optical Filter Control
			[4..15]	Reserved
		Capture_Size	[16]	Capture image size for Format_6
		Capture_Quality	[17]	Capture image quality for Format_6
			[18..31]	Reserved
40Ch .. 47Fh	Reserved			
480h	Advanced_Feature_ Inq	Advanced_Feature _Quadlet_Offset	[0 .. 31]	Quadlet offset of the advanced feature CSR's from the base address of initial register space.(Vendor unique)

offset	0-7	8-15	16-23	24-31
404h	b e s w h s g s	g l f t t	Reserved (all zero)	
408h	z p t o	Reserved (all zero)	s q	Reserved (all zero)
480h	Quadlet offset of the advanced feature CSR			

60

Initial values	System dependent
Read values	System dependent (Same as initial value)
Write effect	Ignored

1.5 Inquiry register for feature elements

All the field named xxx_Inq is bit assignment for inquiry. (0:Not available 1:Available)
(Definition and specification of each feature is described in Appendix A.)

Offset	Name	Field	Bit	Description
500h	BRIGHTNESS_INQ	Presence_Inq	[0]	Presence of this feature
			[1..2]	Reserved
		One_Push_Inq	[3]	One push auto mode (Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/Off_Inq	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto mode (Controlled automatically by camera)
		Manual_Inq	[7]	Manual mode (Controlled by user)
		MIN_Value	[8..19]	MIN value for this feature control
		MAX_Value	[20..31]	MAX value for this feature control
504h	AUTO_EXPOSURE_INQ	Same definition to BRIGHTNESS_INQ		
508h	SHARPNESS_INQ	Same definition to BRIGHTNESS_INQ		
50Ch	WHITE_BAL_INQ	Same definition to BRIGHTNESS_INQ		
510h	HUE_INQ	Same definition to BRIGHTNESS_INQ		
514h	SATURATION_INQ	Same definition to BRIGHTNESS_INQ		
518h	GAMMA_INQ	Same definition to BRIGHTNESS_INQ		
51Ch	SHUTTER_INQ	Same definition to BRIGHTNESS_INQ		
520h	GAIN_INQ	Same definition to BRIGHTNESS_INQ		
524h	IRIS_INQ	Same definition to BRIGHTNESS_INQ		
528h	FOCUS_INQ	Same definition to BRIGHTNESS_INQ		
52Ch	TEMPERATURE_INQ	Same definition to BRIGHTNESS_INQ		
530h	TRIGGER_INQ	Presence_Inq	[0]	Presence of this feature
			[1..3]	Reserved
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/Off_Inq	[5]	Capability of switching this feature ON and OFF
		Polarity_Inq	[6]	Capability of changing polarity of the trigger input
			[7..15]	Reserved
		Trigger_Mode0_Inq	[16]	Presence of Trigger Mode 0
		Trigger_Mode1_Inq	[17]	Presence of Trigger Mode 1
		Trigger_Mode2_Inq	[18]	Presence of Trigger Mode 2
		Trigger_Mode3_Inq	[19]	Presence of Trigger Mode 3
			[20 ..31]	Reserved
534h : 57Ch	Reserved for other FEATURE_HI_INQ			
580h	ZOOM_INQ	Presence_Inq	[0]	Presence of this feature
			[1..2]	Reserved
		One_Push_Inq	[3]	One push auto mode (Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/Off_Inq	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto mode (Controlled automatically by camera)
		Manual_Inq	[7]	Manual mode (Controlled by user)
		MIN_Value	[8..19]	MIN Value for this feature control
		MAX_Value	[20..31]	MAX Value for this feature control
584h	PAN_INQ	Same definition to ZOOM_INQ		
588h	TILT_INQ	Same definition to ZOOM_INQ		
58Ch	OPTICAL_FILTER_INQ	Same definition to ZOOM_INQ		
590h : 5BCh	Reserved for other FEATURE_LO_INQ			
5C0h	CAPTURE_SIZE_INQ	Same definition to ZOOM_INQ		
5C4h	CAPTURE_QUALITY_INQ	Same definition to ZOOM_INQ		
5C8h : 5FCh	Reserved for other FEATURE_LO_INQ			

for TRIGGER_INQ

offset	0-7								8-15								16-23								24-31							
530h	p				r	o											0	1	2	3												

70 for others

offset	0-7								8-15								16-23								24-31							
5xxh	p				o	r	o	a	m	min_value							Max_value																

Initial values	System dependent
Read values	System dependent (Same as initial value)
Write effect	Ignored

1.6 Status and control registers for camera

Offset	Name	Bit	Description
600h	Cur_V_Frm_Rate / Revision	[0..2]	Current frame rate or revision for Format_6 FrameRate_0 .. FrameRate_7 / revision_0 .. revision_7
		[3..31]	Reserved
604h	Cur_V_Mode	[0..2]	Current video mode Mode_0 .. Mode_7
		[3..31]	Reserved
608h	Cur_V_Format	[0..2]	Current video format Format_0 .. Format_7
		[3..31]	Reserved
60Ch	ISO_Channel	[0..3]	Isochronous channel number for video data transmission (except for Format_6)
		[4..5]	Reserved
	ISO_Speed	[6..7]	Isochronous transmit speed code. (except for Format_6)
		[8..31]	Reserved
610h	Camera_Power	[0]	1 = power-up camera 0 = power-down camera.
		[1..31]	Reserved
614h	ISO_EN/ Continuous_Shot	[0]	except for Format_6: 1 = start ISO transmission of video data 0 = stop ISO transmission of video data for Format_6: 1 = start continuous shot and save to storage device. 0 = stop continuous shot if storage device becomes full, self cleared.
		[1..31]	Reserved
618h	Memory_Save	[0]	1 = current status and modes are saved to Mem_Save_Ch (Self Cleared)
		[1..31]	Reserved
61Ch	One_Shot	[0]	except for Format_6: 1 = only one frame of video data is transmitted (Self cleared after transmission) for Format_6: 1 = capture one image and save to storage device. (Self cleared) Ignored if ISO_EN = 1
	Multi_Shot	[1]	except for Format_6: 1 = N frames of video data is transmitted (Self cleared after transmission) N is cycle number. See below. for Format_6: 1 = Capture N images and save to storage device (Self cleared) N is image number. See below. Ignored if ISO_EN = 1
		[2..15]	Reserved
	Count_Number	[16..31]	Count number for Multi shot function.
620h	Mem_Save_Ch	[0..3]	Write channel for Memory_Save command Must be >= 0001 (0 is factory settings, which cannot be overwritten) (see BASIC_FUNC_INQ)
		[4..31]	Reserved
624h	Cur_Mem_Ch	[0..3]	When read from, returns Current Memory Channel number When written to, loads status, modes, and values from the specified memory channel
		[4..31]	Reserved

Initial values	System dependent.
Read values	Last update (Reserved bits are always zero)
Write effect	As indicated in table above

1.6.1 Storage Media CSR (only for Format_6)

Offset	Name	Field	Bit	Description
680h	Media_Status	Media_Presence	[0]	Presence of the Media. 1=presence (Read only)
		Write_Protect	[1]	1 = Write Protected, 0 = Writable
			[2..7]	Reserved
		Occupied_Rate	[8..15]	Percentage of occupied rate.(0x64=100d is full) (Read only)
			[16..31]	Reserved
684h	Number_Of_Images	Expected_Remain	[0..15]	Expected number of images can store If value is 0xffff, must ignore this field. (Read only)
		Number_Of_Images	[16..31]	Number of stored images. (Read only)
688h	Media_Initialize	Initialize_Keyword	[0 ..31]	If the value which is equal to 'Initialize_Keyword' is written, media will be initialized. Initialize_Keyword = 0x46726D74 = 'Frmt'
68Ch	Image_ID for_Delete	Image_ID	[0..15]	Image_ID value to delete one image.
			[16..31]	Reserved
690h	Delete_Image	Delete_Keyword	[0..31]	If the value which is equal to 'Delete_Keyword' is written, one image it's ID is equal to "Image_ID" in 68Ch register will be deleted. Initialize_Keyword = 0x446C7465 = 'Delt'

1.6.2 Stored Image CSR (only for Format_6)

Offset	Name	Field	Bit	Description
6C0h	Image_Number	Image_Number	[0..15]	Select one of the stored image. "Image_Number" must be less than "Number_Of_Images" in 684h register.
			[16..31]	Reserved
6C4h	Image_Status	Write_Protect	[0]	1 = Write Protected, 0 = Writable
			[1..7]	Reserved
		Number_Of_Quality	[8..15]	This value shows number of image quality level in the selected image file. It must be more than Zero. See "Load_Image_Quality" register. (Read Only)
		Image_ID	[15..31]	ID number of selected image. This is unique value in the same storage media. (Read only)
6C8h	Image_Information_Address		[0 ..15]	Reserved
		Address_Hi	[16..31]	Direct base address of the Image Information data. upper 16 bits. (Read only)
6CCh	Image_Information_Address	Address_Lo	[0..31]	Direct base address of the Image Information data. Lower 32 bits. (Read only)
6D0h	Bytes_Of_Image_Information	Total_Bytes	[0..31]	Total amount of bytes of Image information data. If this value is Zero, information data for selected image is not available.
6D4h	Thumbnail_Address		[0 ..15]	Reserved
		Address_Hi	[16..31]	Direct base address of the thumbnail image data. upper 16 bits. (Read only)
6D8h	Thumbnail_Address	Address_Lo	[0..31]	Direct base address of the thumbnail image data. Lower 32 bits. (Read only)
6DCh	Bytes_Of_Thumbnail	Total_Bytes	[0..31]	Total amount of bytes of thumbnail image data. If this value is Zero, thumbnail image of the selected image is not available. (Read only)
6E0h	Load_Image_Quality	Image_Quality	[0..7]	Select image quality level. 0 = whole data of the selected image file. 1 = lowest quality image data 'Image_Quality' <= 'Number_Of_Quality' bigger value means higher quality.
6E4h	Image_Address		[0 ..15]	Reserved
		Address_Hi	[16..31]	Direct base address of the image data. upper 16 bits. (Read only)

6E8h	Image_Address	Address_Lo	[0..31]	Direct base address of the image data. Lower 32 bits. (Read only)
6ECh	Bytes_Of_Image	Total_Bytes	[0..31]	Total amount of bytes of the image data. If this value is Zero, image is not available.

1.7 Status and control register for feature

Offset	Name	Field	Bit	Description
800h	BRIGHTNESS	Presence_Inq	[0]	Presence of this feature 0:N/A 1:Available
			[1-4]	Reserved
		One_Push	[5]	Write '1': begin to work (Self cleared after operation) Read: Value=1 in operation Value=0 not in operation
		ON_OFF	[6]	Write: ON or OFF this feature, Read: read a status 0: OFF, 1: ON
		A_M_Mode	[7]	Write: set the mode, Read: read a current mode 0: Manual, 1: Auto.
			[8-19]	Reserved.
		Value	[20-31]	Value. Write the value in Auto mode, this field is ignored. If "ReadOut" capability is not available, read value has no meaning
804h	AUTO_EXPOSURE	Same definition to BRIGHTNESS		
808h	SHARPNESS	Same definition to BRIGHTNESS		
80Ch	WHITE_BALANCE	Presence_Inq	[0]	Presence of this feature. 0:N/A 1:Available
			[1-4]	Reserved.
		One_Push	[5]	Write '1': begin to work (Self cleared after operation) Read: Value=1 in operation Value=0 not in operation
		ON_OFF	[6]	Write: ON or OFF this feature, Read: read a status 0: OFF, 1: ON
		A_M_Mode	[7]	Write: set the mode, Read: read a current mode 0: Manual, 1: Auto.
		U_Value / B_Value	[8-19]	U Value / B_Value. Write the value in AUTO mode, this field is ignored. If "ReadOut" capability is not available, read value has no mean
		V_Value / R_Value	[20-31]	V Value / R_Value Write the value in AUTO mode, this field is ignored. If "ReadOut" capability is not available, read value has no mean
810h	HUE	Same definition to BRIGHTNESS		
814h	SATURATION	Same definition to BRIGHTNESS		
818h	GAMMA	Same definition to BRIGHTNESS		
81Ch	SHUTTER	Same definition to BRIGHTNESS		
820h	GAIN	Same definition to BRIGHTNESS		
824h	IRIS	Same definition to BRIGHTNESS		
828h	FOCUS	Same definition to BRIGHTNESS		
82Ch	TEMPERATURE	Presence_Inq	[0]	Presence of this feature. 0:N/A 1:Available
			[1-4]	Reserved.
		One_Push	[5]	Write '1': begin to work (Self cleared after operation) Read: Value=1 in operation Value=0 not in operation
		ON_OFF	[6]	Write: ON or OFF this feature, Read: read a status 0: OFF, 1: ON
		A_M_Mode	[7]	Write: set the mode, Read: read a current mode 0: Manual, 1: Auto.

		Target_ Temperature	[8-19]	Aimed value of the temperature. 10 times of the absolute temperature
		Temperature	[20-31]	Temperature at the present time. (read only) 10 times of the absolute temperature
830h	TRIGGER_MODE	Presence_Inq	[0]	Presence of this feature. 0:N/A 1:Available
			[1-5]	Reserved.
		ON_OFF	[6]	Write: ON or OFF this feature, Read: read a status 0: OFF, 1: ON
		Trigger_Polarity	[7]	If Polarity_Inq is "1", write to change polarity of the trigger input read to get polarity of the trigger input. If Polarity_Inq is "0", read only. (0: Low active input, 1: High active input)
			[8 – 11]	Reserved
		Trigger_Mode	[12-15]	Trigger mode. (Trigger_Mode_0 – 15)
			[16 – 19]	Reserved
		Parameter	[20-31]	Parameter for trigger function, if required. (optional)
834h : 87Ch	reserved for other FEATURE_HI			
880h	Zoom	Same definition to BRIGHTNESS		
884h	PAN	Same definition to BRIGHTNESS		
888h	TILT	Same definition to BRIGHTNESS		
88Ch	OPTICAL_FILTER	Same definition to BRIGHTNESS		
890h : 8BCh	Reserved for other FEATURE_LO			
8C0h	CAPTURE_SIZE	Same definition to BRIGHTNESS		
8C4h	CAPTURE_QUALITY	Same definition to BRIGHTNESS		
8C8h : 8FCh	reserved for other FEATURE_LO			

for WHITE_BALANCE

offset	0-7					8-15	16-23	24-31
80Ch	p		o	o	a	U_Value / B_Value	V_Value / R_Value	

for TEMPERATURE

offset	0-7					8-15	16-23	24-31
82Ch	p		o	o	a	Target_Temperature	Temperature	

for TRIGGER_MODE

offset	0-7					8-15		16-23	24-31
830h	p		o	p			T_Mode		Parameter

for others

offset	0-7					8-15	16-23	24-31
8xxh	p		o	o	a		Value	

Initial values	System dependent
Read values	Last update values
Write effect	stored ([0] is read only)

1.8 Register map

Offset	Register
000h	<Camera initialize register> INITIALIZE
100h 180h	<Inquiry register for video format> V_FORMAT_INQ <Inquiry register for video mode> V_MODE_INQ_x
200h	<Inquiry register for video frame rate> V_RATE_INQ_y_x
300h	
400h	<Inquiry register for feature presence> BASIC_FUNC_INQ FEATURE_HI_INQ FEATURE_LO_INQ
500h	<Inquiry register for feature elements> xxxxxxxxxx_INQ
600h	<Status and control register for camera> CAM_STA_CTRL
700h	<Reserved>
800h	<Status and control register for feature> xxxxxxxxxxx

1.9 Video Mode CSR for Format_7

Base address for each video mode command and status registers is:

Bus_ID, Node_ID , FFFF Fxxx xxxx (initial units space)

This address is contained in the Format_7 section of the "1.2.3 Inquiry register for video frame rate and base address of the Video Mode CSR for the Scalable Image Size Format". This register shall be prepared for each video mode
100 that is Format_7, Mode_x.

The offset field in each of the following tables is the byte offset from the above base address.

Offset	Name	Field	Bit	Description	
000h	MAX_IMAGE_SIZE_INQ	Hmax	[0..15]	Maximum Horizontal pixel number	
		Vmax	[16..31]	Maximum Vertical pixel number	
004h	UNIT_SIZE_INQ	Hunit	[0..15]	Horizontal unit pixel number	
		Vunit	[16..31]	Vertical unit pixel number	
008h	IMAGE_POSITION	Left	[0..15]	Left position of requested image region (pixels)	
		Top	[16..31]	Top position of requested image region (pixels)	
00Ch	IMAGE_SIZE	Width	[0..15]	Width of requested image region (pixels)	
		Height	[16..31]	Height of requested image region (pixels)	
010h	COLOR_CODING_ID	Coding_ID	[0..7]	Color coding ID from COLOR_CODING_INQ regs	
		-	[8..31]	Reserved (All zero)	
014h	COLOR_CODING_INQ	Mono8	[0]	Y only. Y=8bits, non compressed	ID=0
		4:1:1 YUV8	[1]	4:1:1, Y=U=V= 8bits, non compressed	ID=1
		4:2:2 YUV8	[2]	4:2:2, Y=U=V=8bits, non compressed	ID=2
		4:4:4 YUV8	[3]	4:4:4, Y=U=V=8bits, non compressed	ID=3
		RGB8	[4]	R=G=B=8bits, non compressed	ID=4
		Mono16	[5]	Y only, Y=16bits, non compressed	ID=5
		RGB16	[6]	R=G=B=16bits, non compressed	ID=6
		-	[7..31]	Reserved (All zero)	ID=7-31
018h : 033h	COLOR_CODING_INQ	Reserved for other Color_Coding.			ID= 32-255
034h	PIXEL_NUMBER_INQ	PixelPerFrame	[0..31]	Pixel number per frame	
038h	TOTAL_BYTES_HI_INQ	BytePerFrameHi	[0..31]	Higher quadlet of total bytes per frame	
03Ch	TOTAL_BYTES_LO_INQ	BytePerFrameLo	[0..31]	Lower quadlet of total bytes per frame	
040h	PACKET_PARA_INQ	UnitBytePerPacket	[0..15]	Minimum bytes per packet	
		MaxBytePerPacket	[16..31]	Maximum bytes per packet	
044h	BYTE_PER_PACKET	BytePerPacket	[0..15]	Packet size	
		-	[16..31]	Reserved (All zero)	

1.9.1 MAX_IMAGE_SIZE_INQ register

This register is an inquiry register for maximum image size.

0-7	8-15	16-23	24-31
Hmax (pixels)		Vmax (pixels)	

Initial values	System dependent
Read values	System dependent (Same as initial value)
Write effect	Ignored

1.9.2 UNIT_SIZE_INQ register

This register is an inquiry register for unit size.

Hmax = Hunit * n (n is integer)
Vmax = Vunit * m (m is integer)

0-7	8-15	16-23	24-31
Hunit (pixels)		Vunit (pixels)	

Initial values	System dependent
Read values	System dependent (Same as initial value)
Write effect	Ignored

1.9.3 IMAGE_POSITION and IMAGE_SIZE register

These registers determine an area of required data. All the data must be as follows

Left = Hunit * n1
Top = Vunit * m1
Width = Hunit * n2
Height = Vunit * m2 (n1, n2, m1, m2 are integer)

Left + Width <= Hmax
Top + Height <= Vmax

0-7	8-15	16-23	24-31
Left		Top	

0-7	8-15	16-23	24-31
Width		Height	

Initial values	All Zero
Read values	Last update value
Write effect	Stored

1.9.4 COLOR_CODING_ID and COLOR_CODING_INQ registers

COLOR_CODING_INQ register describes available color coding capability of the system. Each coding scheme has it's own ID number. Required color coding scheme must be set to COLOR_CODING_ID register as the ID number.

COLOR_CODING_ID register

0-7	8-15	16-23	24-31
Coding_ID	Reserved		

Initial values	All Zero
Read values	Last update value
Write effect	Stored

COLOR_CODING_INQ registers

0-7	8-15	16-23	24-31
Bit assignment is described in the table above			

Initial values	System dependent
Read values	System dependent (Same as initial value)
Write effect	Ignored

1.9.5 PIXEL_NUMBER_INQ and TOTAl_BYTE_INQ registers

PIXEL_NUMBER_INQ register includes total pixel number of required image area. TOTAL_BYTE_INQ register includes total data amount value of required image area as the bytes.
Value of these registers will be updated by writing new value to IMAGE_POSITION, IMAGE_SIZE and COLOR_CODING_ID registers.

PIXEL_NUMBER_INQ register

0-7	8-15	16-23	24-31
PixelPerFrame			

Initial values	All Zero
Read values	Last update value
Write effect	Ignored

TOTAL_BYTE_HI_INQ and TOTAL_BYTE_LO_INQ registers

0-7	8-15	16-23	24-31
Higher part of BytePerFrame			
Lower part of BytePerFrame			

Initial values	All Zero
Read values	Last update value
Write effect	Ignored

1.9.6 PACKET_PARA_INQ register

MaxBytePerPacket describes maximum packet size for one Isochronous packet. UnitBytePerPacket is the unit for Isochronous packet size. This register will be updated by writing new value to IMAGE_POSITION, IMAGE_SIZE and COLOR_CODING_ID registers with the value of ISO_Speed register (60Ch [6..7]).
At first, ISO_Speed register must be written. Then IMAGE_POSITION, IMAGE_SIZE and COLOR_CODING_ID registers should be updated.

0-7	8-15	16-23	24-31
UnitBytePerPacket		MaxBytePerPacket	

Initial values	All Zero
Read values	Last update value
Write effect	Ignored

1.9.7 BYTE_PER_PACKET register

BytePerPacket value determines real packet size and transmission speed for one frame image. BytePerPacket value must keep following condition.

BytePerPacket = UnitBytePerPacket * n (n is integer)
BytePerPacket <= MaxBytePerPacket

0-7	8-15	16-23	24-31
BytePerPacket		Reserved (All zero)	

Initial values	All Zero
Read values	Last update value
Write effect	Stored

1.10 Advanced Feature CSR's

These CSR's are for vendor unique features. Vendor shall prepare CSR's for these additional features and write base address of these CSR's at 480h as a quadlet offset value from the base address of initial register space.
First two quadlets are "Access Control Register"(ACR). User has to write "Feature_ID" to ACR to unlock "Advanced Feature CSR's". Each model that implements "Advanced Feature CSR's" must have "Feature_ID". "Feature_ID" is advanced feature set unique value and consists of 48bits.
Remaining structure of this area has to be determined by vendor.

User can determine Time_Out value with unlock operation. Time_out value consists of 12 bits and unit is millisecond. (Maximum 4.095 second)
If user does not access "Advanced Feature CSR's" within Time_Out value, unlock operation will be canceled and ACR will return to initial state. If user access "Advanced Feature CSR's" within Time_Out value, Time_out will be refreshed.
If user node unlocks "Advanced Feature CSR's" user node's Bus_ID and Node_ID value will be copied in the ACR. Then other node can not access nor unlock this CSR area. If bus reset occur, ACR will be initialized.

Access Control Register

Write format

0-7	8-15	16-23	24-31
Feature_ID_Hi			
Feature_ID_Lo		0xf	Time_Out

Read format

0-7	8-15	16-23	24-31
Bus_ID+Node_ID		0xffff	
0xffffff			Time_Out

Initial values	All one (0xffffffffffffffff)
Read values	Last update value
Write effect	If upper 48 bits of written value is equal to "Feature_ID", store source Bus_ID+Node_ID(16 bits) value to upper 16bits area. Also, Time_Out value, lower 12 bits value, is stored. Other bits will be one. If upper 48 bits of written value is not equal to "Feature_ID", write action is ignored and all bits will be one.
Bus Reset	All one

Feature_ID

0-7	8-15	16-23	24-31	32-39	40-47
Company_ID			Advanced feature set unique value		

Each company has to manage lower 3 bytes value to keep advanced feature set uniqueness.

2. Isochronous packet format

Every video format, mode and frame rate has different video data format.

2.1 Isochronous packet format for Format_0, Format_1 and Format_2

2.1.1 Video isochronous packet structure

The following table shows the format of the first quadlet in the data field of each isochronous data block.

0-7	8-15	16-23		24-31	
data_length		tg	channel	tCode	sy
header_CRC					
Video data payload					
data_CRC					

Isochronous Data Block Packet Format

Where the following fields are defined in the IEEE 1394 standard:

data_length : number of bytes in the data field

tg : (tag field) shall be set to zero

channel : isochronous channel number, as programmed in the iso_channel field of the cam_sta_ctrl register

tCode : (transaction code) shall be set to the isochronous data block packet tCode

sy : (synchronization value) shall be set to 0001h on the first isochronous data block of a frame, and shall be set to zero on all other isochronous data blocks

Video data payload : shall contain the digital video information, as defined in the following sections

2.1.2 Video mode comparison chart

Every component Y,U,V,R,G,B has 8 bit data.

Format_0

Mode	Video Format	60fps	30fps	15fps	7.5fps	3.75fps
Mode_0	160x120 YUV(4:4:4) 24bit/pixel		1/2H 80p 60q	1/4H 40p 30q	1/8H 20p 15q	
Mode_1	320x240 YUV(4:2:2) 16bit/pixel		1H 320p 160q	1/2H 160p 80q	1/4H 80p 40q	1/8H 40p 20q
Mode_2	640x480 YUV(4:1:1) 12bit/pixel		2) 2H 1280p 480q	1H 640p 240q	1/2H 320p 120q	1/4H 160p 60q
Mode_3	640x480 YUV(4:2:2) 16bit/pixel		4) 2H 1280p 640q	2) 1H 640p 320q	1/2H 320p 160q	1/4H 160p 80q
Mode_4	640x480 RGB 24bit/pixel		4) 2H 1280p 960q	2) 1H 640p 480q	1/2H 320p 240q	1/4H 160p 120q
Mode_5	640x480 Y (Mono) 8bit/pixel	4) 4H 2560p 640q	2) 2H 1280p 320q	1H 640p 160q	1/2H 320p 80q	1/4H 160p 40q
Mode_6	Reserved					
Mode_7	Reserved					

Format_1

Mode	Video Format	60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
Mode_0	800x600 YUV(4:2:2) 16bit/pixel		4) 5/2H 2000p 1000q	2) 5/4H 1000p 500q	5/8H 500p 250q	5/16H 250p 125q	
Mode_1	800x600 RGB 24bit/pixel			4) 5/4H 1000p 750q	2) 5/8H 500p 375q		
Mode_2	800x600 Y (Mono) 8bit/pixel	4) 5H 4000p 1000p	2) 5/2H 2000p 500q	5/4H 1000p 250q	5/8H 500p 125q		
Mode_3	1024x768 YUV(4:2:2) 16bit/pixel			4) 3/2H 1536p 768q	2) 3/4H 768p 384q	3/8H 384p 192q	3/16H 192p 96q
Mode_4	1024x768 RGB 24bit/pixel				4) 3/4H 768p 576q	2) 3/8H 384p 288q	3/16H 192p 144q
Mode_5	1024x768 Y (Mono) 8bit/pixel		4) 3H 3072p 768q	2) 3/2H 1536p 384q	3/4H 768p 192q	3/8H 384p 96q	3/16H 192p 48q
Mode_6	Reserved						
Mode_7	Reserved						

230

Format_2

Mode	Video Format	60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
Mode_0	1280x960 YUV(4:2:2) 16bit/pixel				4) 1H 1280p 640q	2) 1/2H 640p 320q	1/4H 320p 160q
Mode_1	1280x960 RGB 24bit/pixel				4) 1H 1280p 960q	2) 1/2H 640p 480q	1/4H 320p 240q
Mode_2	1280x960 Y (Mono) 8bit/pixel			4) 2H 2560p 640q	2) 1H 1280p 320q	1/2H 640p 160q	1/4H 320p 80q
Mode_3	1600x1200 YUV(4:2:2) 16bit/pixel				4) 5/4H 2000p 1000q	2) 5/8H 1000p 500q	5/16H 500p 250q
Mode_4	1600x1200 RGB 24bit/pixel					4) 5/8H 1000p 750q	2) 5/16H 500p 375q
Mode_5	1600x1200 Y (Mono) 8bit/pixel			4) 5/2H 4000p 1000q	2) 5/4H 2000p 500q	5/8H 1000p 250q	5/16H 500p 125q
Mode_6	Reserved						
Mode_7	Reserved						

[---H : Line / Packet]
2) : required S200 data rate [---p : Pixel / Packet]
4) : required S400 data rate [---q : Quadlet / Packet]

2.1.3 Video data payload structure

Pn : Pixel number / packet
K : $Pn \times n$ (n = 0..N-1)
($Pn \times N$ = Total pixel number / frame.)

<YUV (4: 4: 4) format >

U-(K+0)	Y-(K+0)	V-(K+0)	U-(K+1)
Y-(K+1)	V-(K+1)	U-(K+2)	Y-(K+2)
V-(K+2)	U-(K+3)	Y-(K+3)	V-(K+3)
U-(K+Pn-4)	Y-(K+Pn-4)	V-(K+Pn-4)	U-(K+Pn-3)
Y-(K+Pn-3)	V-(K+Pn-3)	U-(K+Pn-2)	Y-(K+Pn-2)
V-(K+Pn-2)	U-(K+Pn-1)	Y-(K+Pn-1)	V-(K+Pn-1)

<YUV (4: 2: 2)format >

U-(K+0)	Y-(K+0)	V-(K+0)	Y-(K+1)
U-(K+2)	Y-(K+2)	V-(K+2)	Y-(K+3)
U-(K+4)	Y-(K+4)	V-(K+4)	Y-(K+5)
U-(K+Pn-6)	Y-(K+Pn-6)	V-(K+Pn-6)	Y-(K+Pn-5)
U-(K+Pn-4)	Y-(K+Pn-4)	V-(K+Pn-4)	Y-(K+Pn-3)
U-(K+Pn-2)	Y-(K+Pn-2)	V-(K+Pn-2)	Y-(K+Pn-1)

<YUV (4: 1: 1)format >

U-(K+0)	Y-(K+0)	Y-(K+1)	V-(K+0)
Y-(K+2)	Y-(K+3)	U-(K+4)	Y-(K+4)
Y-(K+5)	V-(K+4)	Y-(K+6)	Y-(K+7)
U-(K+Pn-8)	Y-(K+Pn-8)	Y-(K+Pn-7)	V-(K+Pn-8)
Y-(K+Pn-6)	Y-(K+Pn-5)	U-(K+Pn-4)	Y-(K+Pn-4)
Y-(K+Pn-3)	V-(K+Pn-4)	Y-(K+Pn-2)	Y-(K+Pn-1)

<RGB format >

R-(K+0)	G-(K+0)	B-(K+0)	R-(K+1)
G-(K+1)	B-(K+1)	R-(K+2)	G-(K+2)
B-(K+2)	R-(K+3)	G-(K+3)	B-(K+3)
R-(K+Pn-4)	G-(K+Pn-4)	B-(K+Pn-4)	R-(K+Pn-3)
G-(K+Pn-3)	B-(K+Pn-3)	R-(K+Pn-2)	G-(K+Pn-2)
B-(K+Pn-2)	R-(K+Pn-1)	G-(K+Pn-1)	B-(K+Pn-1)

<Y (Mono)format >

Y-(K+0)	Y-(K+1)	Y-(K+2)	Y-(K+3)
Y-(K+4)	Y-(K+5)	Y-(K+6)	Y-(K+7)
Y-(K+Pn-8)	Y-(K+Pn-7)	Y-(K+Pn-6)	Y-(K+Pn-5)
Y-(K+Pn-4)	Y-(K+Pn-3)	Y-(K+Pn-2)	Y-(K+Pn-1)

2.1.4 Data structure

<Y, R, G, B>

Each component has 8bit data. Data type is ‘Unsigned Char”.

	Signal level (Decimal)	Data (Hexadecimal)
Highest	255	0xFF
	254	0xFE
	:	:
	1	0x01
Lowest	0	0x00

<U, V>

Each component has 8bit data. Data type is “Straight Binary”.

	Signal level (Decimal)	Data (Hexadecimal)
Highest(+)	127	0xFF
	126	0xFE
	:	:
	1	0x81
Lowest	0	0x80
	-1	0x7F
	:	:
	-127	0x01
Highest(-)	-128	0x00

2.2 Isochronous packet format for Scalable image size video format (Format_7)

2.2.1 Video isochronous packet structure

The following table shows the format of the first quadlet in the data field of each isochronous data block.

0-7	8-15	16-23		24-31	
data_length		tg	channel	tCode	sy
header_CRC					
Video data payload					
data_CRC					

Isochronous Data Block Packet Format

Where the following fields are defined in the IEEE 1394 standard:

data_length : number of bytes in the data field

tg : (tag field) shall be set to zero

channel : isochronous channel number, as programmed in the iso_channel field of the cam_sta_ctrl register

tCode : (transaction code) shall be set to the isochronous data block packet tCode

sy : (synchronization value) shall be set to 0001h on the first isochronous data block of a frame, and shall be set to zero on all other isochronous data blocks

Video data payload : shall contain the digital video information, as defined in the following sections

2.2.2 Video data payload structure

Pn : Pixel number / packet

K : $Pn \times n$ (n = 0..N-1)

($Pn \times N$ = Total pixel number / frame.)

< **Mono8 format (color coding ID = 0)** >

Y component has 8bit data.

Y-(K+0)	Y-(K+1)	Y-(K+2)	Y-(K+3)
Y-(K+4)	Y-(K+5)	Y-(K+6)	Y-(K+7)
Y-(K+Pn-8)	Y-(K+Pn-7)	Y-(K+Pn-6)	Y-(K+Pn-5)
Y-(K+Pn-4)	Y-(K+Pn-3)	Y-(K+Pn-2)	Y-(K+Pn-1)

< **4:1:1 YUV8 format (color coding ID = 1)**>

Each component has 8bit data.

U-(K+0)	Y-(K+0)	Y-(K+1)	V-(K+0)
Y-(K+2)	Y-(K+3)	U-(K+4)	Y-(K+4)
Y-(K+5)	V-(K+4)	Y-(K+6)	Y-(K+7)
U-(K+Pn-8)	Y-(K+Pn-8)	Y-(K+Pn-7)	V-(K+Pn-8)
Y-(K+Pn-6)	Y-(K+Pn-5)	U-(K+Pn-4)	Y-(K+Pn-4)
Y-(K+Pn-3)	V-(K+Pn-4)	Y-(K+Pn-2)	Y-(K+Pn-1)

< 4:2:2 YUV8 format (color coding ID = 2) >

Each component has 8bit data.

U-(K+0)	Y-(K+0)	V-(K+0)	Y-(K+1)
U-(K+2)	Y-(K+2)	V-(K+2)	Y-(K+3)
U-(K+4)	Y-(K+4)	V-(K+4)	Y-(K+5)
U-(K+Pn-6)	Y-(K+Pn-6)	V-(K+Pn-6)	Y-(K+Pn-5)
U-(K+Pn-4)	Y-(K+Pn-4)	V-(K+Pn-4)	Y-(K+Pn-3)
U-(K+Pn-2)	Y-(K+Pn-2)	V-(K+Pn-2)	Y-(K+Pn-1)

300

< 4:4:4 YUV8 format (color coding ID = 3) >

Each component has 8bit data.

U-(K+0)	Y-(K+0)	V-(K+0)	U-(K+1)
Y-(K+1)	V-(K+1)	U-(K+2)	Y-(K+2)
V-(K+2)	U-(K+3)	Y-(K+3)	V-(K+3)
U-(K+Pn-4)	Y-(K+Pn-4)	V-(K+Pn-4)	U-(K+Pn-3)
Y-(K+Pn-3)	V-(K+Pn-3)	U-(K+Pn-2)	Y-(K+Pn-2)
V-(K+Pn-2)	U-(K+Pn-1)	Y-(K+Pn-1)	V-(K+Pn-1)

<RGB8 format (color coding ID = 4) >

Each component has 8bit data.

R-(K+0)	G-(K+0)	B-(K+0)	R-(K+1)
G-(K+1)	B-(K+1)	R-(K+2)	G-(K+2)
B-(K+2)	R-(K+3)	G-(K+3)	B-(K+3)
R-(K+Pn-4)	G-(K+Pn-4)	B-(K+Pn-4)	R-(K+Pn-3)
G-(K+Pn-3)	B-(K+Pn-3)	R-(K+Pn-2)	G-(K+Pn-2)
B-(K+Pn-2)	R-(K+Pn-1)	G-(K+Pn-1)	B-(K+Pn-1)

< Mono16 format (color coding ID = 5) >

Y component has 16bit data.

High byte	Low byte

Y-(K+0)	Y-(K+1)
Y-(K+2)	Y-(K+3)
Y-(K+Pn-4)	Y-(K+Pn-3)
Y-(K+Pn-2)	Y-(K+Pn-1)

< RGB16 format (color coding ID = 6) >

Each component has 16bit data.

High byte	Low byte

R-(K+0)	G-(K+0)
B-(K+0)	R-(K+1)
G-(K+1)	B-(K+1)
B-(K+Pn-2)	R-(K+Pn-1)
G-(K+Pn-1)	B-(K+Pn-1)

2.2.3 Data structure

< Mono8, RGB8 >

Each component (Y, R, G, B) has 8bit data. Data type is 'Unsigned Char".

Y,R,G,B	Signal level (Decimal)	Data (Hexadecimal)
Highest	255	0xFF
	254	0xFE
	:	:
	1	0x01
Lowest	0	0x00

< YUV8 >

Each component (Y, U, V) has 8bit data. Y component is same as above table.
Data type is "Straight Binary" for U and V data.

U, V	Signal level (Decimal)	Data (Hexadecimal)
Highest(+)	127	0xFF
	126	0xFE
	:	:
	1	0x81
Lowest	0	0x80
	-1	0x7F
	:	:
	-127	0x01
Highest(-)	-128	0x00

< Mono16, RGB16 >

330 Each component (Y,R,G,B) has 16bit data. Data type is ‘Unsigned Short (big-endian)”.

Y,R,G,B	Signal level (Decimal)	Data (Hexadecimal)
Highest	65535	0xFFFF
	65534	0xFFFE
	:	:
	1	0x0001
Lowest	0	0x0000

3. Serial bus management

This chapter describes the camera behavior on a given Serial Bus . (IEEE 1394 Digital Camera is in accordance with IEEE standard 1212-1991.)

3.1 Bus Management

An IEEE 1394 Digital Camera complying with this standard is a peripheral for a personal computer or workstation. Another node on the IEEE 1394 bus, such as a computer, acts as the camera controller.
In order for the camera to perform any action, the camera controller must access the camera control registers, as described in this standard. A camera which is compliant with this protocol standard is a passive device. It initiates no actions of its own. The camera is neither isochronous manager capable nor full bus manager capable. The camera is also not cycle master capable. The contents of the self_ID packet generated by the camera, and the contents of camera configuration ROM shall accurately reflect this level of capability.
In order for the camera to perform any action, it must be connected to other IEEE 1394 nodes. At a minimum, there must be a cycle master capable node and an isochronous manager capable node. In addition, there must be some node which is running application software that implements the protocol described in this standard. Note that all of these capabilities could reside in a single node.
The camera controller is responsible for the following activities related to camera operation:

1) Force a cycle master capable node to be the root

2) Start cycle master operation

3) Initialize the camera control registers for a desired video mode, frame rate, etc.

4) Allocate isochronous resources needed by the camera (isochronous channel number and bandwidth, as needed for the selected video mode)

5) Program the isochronous channel number and transmit speed into the camera control registers

6) Instruct the camera to start sourcing isochronous video data

The camera continues sourcing isochronous video data until the camera controller instructs the camera to stop. If a bus reset occurs during camera operation, the camera continues sourcing isochronous data immediately after the bus reset.

3.2 Asynchronous Transfer Capabilities

The IEEE 1394 Digital Camera shall be capable of sending and receive the asynchronous packets with a payload of up to 32 quadlets. This protocol does not use any asynchronous transactions which exceed this limit.
If a node sends a request packet to the digital camera between the request and corresponding response subaction, the digital camera will acknowledge that packet with a “busy” acknowledge code.

3.3 Isochronous Transfer Capabilities

IEEE 1394 Digital Camera is capable of being an isochronous talker. The camera is not capable of listening to a channel of isochronous data.
The digital camera is capable of transmitting isochronous data on channels 0 to 15 only, inclusive.

3.4 IEEE 1394 Specific Address Space

A IEEE 1394 camera which is compliant with this standard shall be compliant with the IEEE 1394 and IEEE 1212 standards.

The following sections define all CSR and ROM locations that the camera shall implement. All information in these sections is intended to comply with the IEEE 1394 standard. Where discrepancies arise, the IEEE 1394 standard shall prevail. All address offset locations in these sections are with respect to a base address of:

FFFF F000 0000h

3.4.1 Implemented CSR's

The digital camera implements the following core CSR's, as required by the IEEE 1394 standard:

Offset	0-7	8-15	16-23	24-31
0000h	STATE_CLEAR			
0004h	STATE_SET			
0008h	NODE_IDS			
000Ch	RESET_START			
0010h				
0014h				
0018h	SPLIT_TIMEOUT_HI			
001Ch	SPLIT_TIMEOUT_LO			

Core CSR's

The digital camera implements the following IEEE 1394 Serial Bus dependent CSR's:

Offset	0-7	8-15	16-23	24-31
0200h	CYCLE_TIME			
0204h				
0208h				
020Ch				
0210h	BUSY_TIMEOUT			

Serial Bus Dependent CSR's

3.4.2 Configuration ROM

IEEE 1394 Digital Camera implements the Configuration ROM as defined in IEEE standard 1212-1991 and IEEE standard 1394-1995.

unit_sw_version = 0x000101 (for 1394 based Digital Camera specification version 1.20)

History:

- unit_sw_version = 0x000100 (for 1394 based Digital Camera specification version 1.04)

	Offset	0-7	8-15	16-23	24-31
Bus Info Block	400h	04h	crc_length	rom_crc_value	
	404h	31h	33h	39h	34h
	408h	0 0 1 0 rsv	FFh	max_rec	Rsv
	40Ch	node_vendor_id			Chip_id_hi
	410h	chip_id_lo			
Root Directory	414h	0004h		CRC	
	418h	03h	module_vendor_ID		
	41Ch	0Ch	rsv	1 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0	
	420h	8Dh	indirect_offset		
	424h	D1h	unit_directory offset		

Root Directory

	Offset	0-7	8-15	16-23	24-31
Node unique ID leaf	0000h	0002h		CRC	
	0004h	node_vendor_id			Chip_id_hi
	0008h	chip_id_lo			

Node Unique ID leaf

	Offset	0-7	8-15	16-23	24-31
Unit Directory	0000h	0003h		CRC	
	0004h	12h	unit_spec_ID (=0x00A02D)		
	0008h	13h	unit_sw_version		
	000Ch	D4h	unit_dependent_directory offset		

Unit directory

	Offset	0-7	8-15	16-23	24-31
Unit Dependent Info	0000h	unit_dep_info_length		CRC	
	0004h	40h	command_regs_base		
	0008h	81h	vendor_name_leaf		
	000Ch	82h	model_name_leaf		

Unit Dependent Directory

Where:

command_regs_base is the quadlet offset from the base address of initial register space of the base address of the command registers defined in section 1 of this standard

vendor_name_leaf specifies the number of quadlets from the address of the vendor_name_leaf entry to the address of the vendor_name leaf containing an ASCII representation of the vendor name of this node

model_name_leaf specifies the number of quadlets from the address of the model_name_leaf entry to the address of the model_name leaf containing an ASCII representation of the model name of this node

3.4.3 Format of Vendor Name and Model Name Leaves

The unit dependent directory may contain pointers to information leaves which contain the ASCII name of the vendor and model name for this node. The format of these leaves is shown in the following table:

	Offset	0-7	8-15	16-23	24-31
Name Leaf	0000h	leaf_length		CRC	
	0004h	00h	00 0000h		
	0008h	0000 0000h			
	000Ch	char_0	char_1	char_2	char_3
	0010h	char_4	char_5	char_6	char_7
	0014h	char_8	...		
	n+6h	...			char_n-3
	n+Ah	char_n-2	char_n-1	NUL	NUL

Vendor Name/Model Name Leaves

A. Appendix A (Feature definition and specification)

A.1 Brightness

Black level of the picture.

A.2 Auto Exposure

This feature is similar to “Contrast control”.

Auto mode:
Camera controls exposure level automatically by itself continuously.

Manual mode:
Camera controls exposure level automatically, but user can change reference level by writing value to “Auto_Exposure” register.

Off mode:
exposure will be controlled manually using “Gain”, “Iris” and/or “Shutter” features.

A.3 Sharpness

Sharpness of the picture.

A.4 White Balance

Adjustment of the white color of the picture..

At the YUV video mode, controlled by U value and V value.
At the RGB video mode, controlled by B value and R value.

A.5 Hue

Color phase of the picture.

A.6 Saturation

Color saturation of the picture..

A.7 Gamma

Define the function between incoming light level and output picture level.

$y = f(x)$

y : output picture level
x : incoming light level

A.8 Shutter

Integration time of the incoming light.

A.9 Gain

Camera circuit gain control.

A.10 Iris

Mechanical lens iris control.

A.11 Focus

Lens focus control.

A.12 Temperature

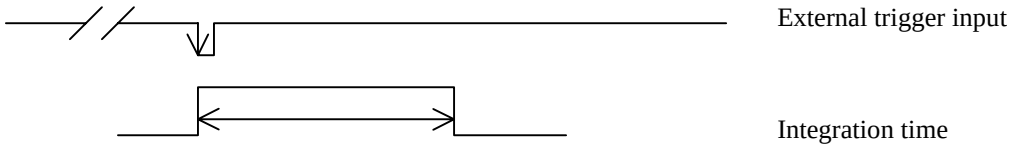
Getting temperature inside of the camera and/or controlling temperature.

1) "One push" mode
   Camera controls temperature by itself aims to "Target_Temperature" value only once. User can get temperature at the present time from "Temperature" value.
2) "Auto" mode
   Camera controls temperature by itself aims to "Target_Temperature" continuously.
   User can get temperature at the present time from "Temperature" value.
3) "Manual" mode
   In this mode, user can only get temperature at the present time from "Temperature" value.

A.13 Trigger

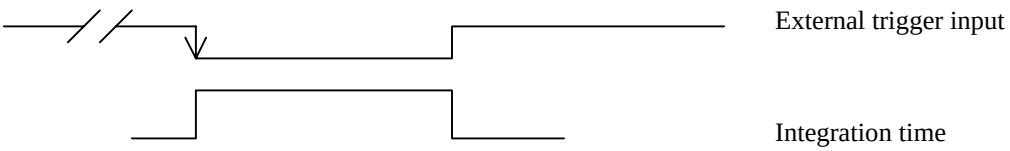
If this feature is turned on, trigger function will work. If turned off, trigger input is ignored.
In the following explanation, trigger input is Low-Active. (Trigger_Polarity = 0)

Trigger mode 0:
Camera starts integration of the incoming light from external trigger input falling edge. Integration time is described in "Shutter" register. No need parameter.

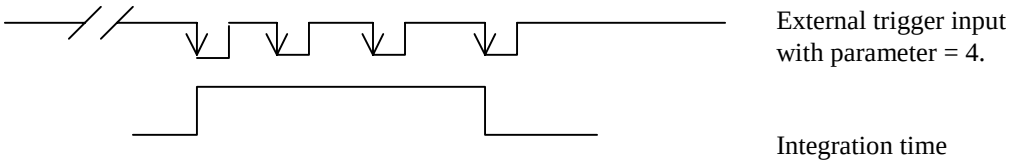


"Shutter" register value

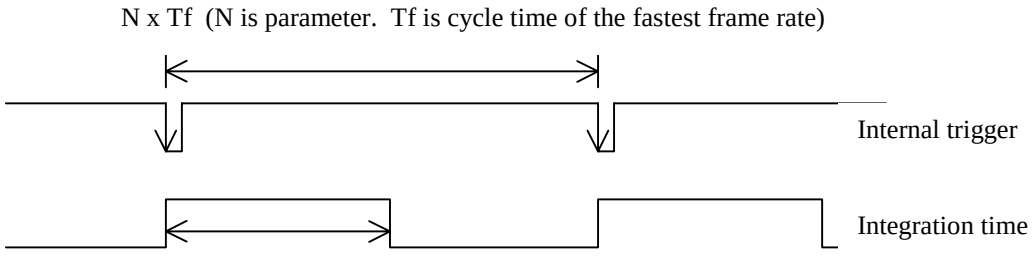
Trigger mode 1:
Camera starts integration of the incoming light from external trigger input falling edge. Integration time is equal to low state time of the external trigger input. No need parameter



Trigger mode 2:
Camera starts integration of incoming light from first external trigger input falling edge. At the N-th (parameter) external trigger input falling edge, integration will be stopped.
Parameter is required and must be more than two.



Trigger mode 3:
This is a internal trigger mode. Camera will issue trigger internally and cycle time is N times (parameter) of the cycle time of fastest frame rate. Integration time of incoming light is described in "Shutter" register.



A.14 Zoom
Lens zoom control.

A.15 Pan
Camera pan control.

A.16 Tilt
Camera tilt control.

A.17 Optical filter
Changing optical filter of camera lens function.